THE PRESIDIO TRUST

13 October 2005

Mr. Bob Boggs
California Department of Toxic Substances Control
700 Heinz Avenue, Suite 200
Berkeley, CA 94710-2721

**Subject: Field Sampling Plan for a Vapor Intrusion Assessment at Building 937, dated 13 October 2005
Presidio of San Francisco, California**

Dear Mr. Boggs:

Enclosed for your review is the document entitled "*Field Sampling Plan for a Vapor Intrusion Assessment at Building 937 Presidio of San Francisco, California*" dated 13 October 2005.

At this time, the Trust is planning for a leasehold tenant to occupy Building 937, beginning in early to mid 2006. In light of these plans, we are scheduled to perform the first round of subslab vapor sampling described in this Field Sampling Plan as soon as possible, but no later than 1 December 2005. Therefore, I would appreciate DTSC's review and concurrence of the sampling proposed in this report as soon as possible.

Please contact me at (415) 561-4259 if you have any questions.

Sincerely yours,
The Presidio Trust

for Craig Cooper
Remediation Program Manager

Enclosure

Cc (with enclosure):
Brian Ullensvang, National Park Service (NPS)
Devender Narala, Regional Water Quality Control Board (RWQCB)
Doug Kern, Restoration Advisory Board (RAB)
Mark Youngkin, RAB

Erler & Kalinowski, Inc.

Consulting Engineers and Scientists

1870 Ogden Drive
Burlingame, CA 94010
(650) 292-9100
Fax (650) 552-9012

13 October 2005

Mr. Craig Cooper
The Presidio Trust
1750 Lincoln Boulevard
P.O. Box 29052
San Francisco, CA 94129-0052

Subject: **Field Sampling Plan for a Vapor Intrusion Assessment at Building 937**
Presidio of San Francisco, California
EKI A000003.08

Dear Mr. Cooper:

On behalf of the Presidio Trust ("Trust"), Erler & Kalinowski, Inc. ("EKI") has prepared this Field Sampling Plan ("FSP") for a vapor intrusion assessment, which will include subslab soil vapor samples and chemical analysis from nine locations and, if needed, air samples and chemical analysis at Building 937 at the Presidio of San Francisco. Building 937 is located within the Crissy Field Operable Unit and was addressed in the *Crissy Field Operable Unit 4 Implementation Report*, dated July 2004 (EKI, 2004). If the results of the subslab vapor sampling and chemical analysis described herein show that the estimated human health risks to future building occupants due to the presence of residual chemicals of concern ("COCs") in shallow soil and groundwater near or under Building 937 remaining from Army activities is potentially significant, then indoor air sampling and analysis will be performed. The results of the indoor air sampling will be used to determine if mitigation measures are necessary to reduce potential risks to future building occupants.

EKI has prepared this FSP based on an 8 August 2005 request by Mr. Robert Boggs of the California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC"). The scope and objectives of the Building 937 FSP were developed taking into account the DTSC guidance (DTSC, 2004), U.S. Environmental Protection Agency ("U.S. EPA") guidance (U.S. EPA, 2002), and consultation with the Trust, the National Park Service ("NPS"), DTSC, and Regional Water Quality Control Board, San Francisco Bay Region ("RWQCB"). The FSP incorporates input received at a 13 September 2005 meeting with DTSC, RWQCB, Trust, and NPS representatives where the draft Data Quality Objectives ("DQOs") were discussed, and at a 22 September 2005 site visit to Building 937 with DTSC, Trust, and NPS representatives where subslab sample locations were selected and marked. This FSP will be provided to the DTSC, RWQCB, and members of the Restoration Advisory Board ("RAB"). Collectively, these parties are referred to as the "stakeholders." The scope of work will be conducted in

accordance with the Presidio-wide Quality Assurance Project Plan ("QAPP") (Tetra Tech, 2001).

BACKGROUND

Building 937 is located approximately 450 feet from the San Francisco Bay at the northern portion of the Presidio (Figure 1), with an interior building area of approximately 17,600 square feet. Generally, the building overlies fill. The depth to groundwater varies between approximately five and eight feet below ground surface.

The following is a summary overview of the remedial actions at Building 937, as documented in EKI's Crissy Field Implementation Report (EKI, 2004).

Historically, the Army operated a 500-gallon waste oil underground storage tank ("UST") and a 1,000-gallon xylenes UST (USTs 937.1 and 937.2). In 1981, during the installation of a hydraulic lift and associated UST (UST 937.H) situated in the southeastern portion of Building 937, petroleum hydrocarbons were reportedly observed in soil. Between 1982 and 1984, the Army installed 22 groundwater monitoring wells in the vicinity of Building 937, which identified free product in wells closest to the Building 937 underground USTs (located on the northern side of the building), with measured thickness ranging between 6 and 36 inches. By 1990, the Army installed 9 additional groundwater monitoring wells in the Building 937 area. In 1992, the Army performed an Interim Remedial Action ("IRA"). This IRA included removal of the tanks and impacted soil as well as the installation of 3 additional groundwater monitoring wells in the Building 937 area. In May 1992, well points were installed upgradient and downgradient of the Building 937 UST area. No free product was observed in the well points. The locations of the three well points (937WP01, 937WP02, and 937WP04) inside the building are shown on Figure 1.

As part of the IRA, the two USTs were removed along with approximately 500 cubic yards of soil. Part of this excavation was inside Building 937 but was limited to avoid structural damage to the building. Post-excavation verification soil samples were collected and petroleum-related constituents detected in the verification soil samples included total extractable hydrocarbons ("TEH"), total volatile hydrocarbons ("TVH"), xylenes, toluene, ethylbenzene, lead, and other volatile compounds such as acetone and chlorobenzene. Benzene was not detected in the verification soil samples (Watkins-Johnson, 1993).

Between 1994 and 1998, a vacuum vaporization system operated to remove volatile organic compounds from the groundwater. This system ultimately was removed in 1998.

In 1998, the Army excavated soil from 2 locations on the north side of Building 937: outside the northwest corner of Building 937, and outside the northeast corner, adjacent to and within the footprint of the 1992 excavation. Chemical concentrations in the

sidewall verification soil samples from northwest corner of the building were less than the applicable cleanup levels.

For the second excavation in 1998, the Army excavated approximately 2,605 tons of soil from the northeast corner outside of Building 937. Chemicals detected in the verification soil samples in the excavation wall at the 7.5-foot depth adjacent to Building 937 included total petroleum hydrocarbons as gasoline, diesel, and fuel oil ("TPHg, TPHd, TPHfo"), benzene, and toluene. Chemical concentrations were less than the applicable cleanup levels in all verification samples, except for three samples collected adjacent to Building 937, which could not be removed due to the potential for structural damage to the building. Chlorinated volatile organic compounds ("VOCs"), such as trichloroethene and its breakdown products were not detected in the confirmation soil samples (International Technology Corporation, 1998).

In May 2002, the Trust installed 3 soil borings to look for the presence of free-phase hydrocarbons in the smear zone and saturated zone at Building 937. TPHg, TPHd, TPHfo, ethylbenzene, and xylenes were detected in soil samples. No free-phase hydrocarbons were observed, and no VOCs were detected (Treadwell & Rollo, 2003).

In July 2004, EKI, on behalf of the Trust, prepared the Crissy Field Implementation Report (EKI, 2004) to document remedial actions at the Crissy Field sites and to request closure for the sites from the regulatory agencies.

The Trust is planning to lease Building 937 to tenants for commercial use.

The objectives and rationale of the subslab soil vapor and indoor air sampling and analysis are described in the Data Quality Objectives section, below.

DATA QUALITY OBJECTIVES

The data quality objectives ("DQOs") are summarized in Table 1. These DQOs are designed to guide the collection of additional data needed to evaluate the potential for human health risks in indoor air from residual COCs in soil and groundwater under Building 937. Since the Trust plans to lease Building 937 to commercial businesses, the risk to future recreational or commercial building occupants from exposure to residual subsurface chemicals through the vapor intrusion exposure pathway should be evaluated. The DQOs identify the decisions that will be made based on the DTSC and EPA guidances. In addition, Table 2 identifies the exposed populations and exposure pathways for the vapor intrusion evaluation, and Table 3 identifies the exposure assumptions that will be used to calculate the hypothetical human health risk for indoor air at Building 937. Many of the exposure assumptions presented in Tables 2 and 3 are similar to those used in the Trust's Cleanup Level Document (EKI, 2002); however, vapor intrusion was not considered for recreational exposure in that document. In

addition, the exposure assumptions presented in Table 3 are based on site-specific information about the planned building use.

As described in Table 1 and shown on Figure 1, a total of nine subslab soil vapor sample locations are proposed at Building 937, in locations agreed upon with the DTSC. The results of the first subslab vapor sampling event will be used to calculate potential risks to future building occupants using the methods described below. If calculated hypothetical health risks at a given sampling location are equal to or less than a cumulative lifetime incremental cancer risk of one-in-one million (10^{-6}) or a total non-carcinogenic hazard index ("HI") is equal to or less than one, then indoor air sampling will not be performed. If indoor air sampling is determined to be necessary, then indoor air sample locations will be proposed by the Trust based on the sampling data and presented to the DTSC and the other stakeholders for review and concurrence.

FIELD ACTIVITIES

Pre-Field Activities

To prepare Building 937 for the subslab soil vapor and indoor/ambient air sampling described in this FSP, prior to field activities, the Trust will remove all equipment that is currently stored inside Building 937, pressure-wash the floor of the building, and flush the centrally located floor drain. These steps will be conducted to eliminate any potential sources of contaminants currently existing in the building.

General Field Procedures for Collection of Subslab Soil Vapor Samples

As described in the DQO table (Table 1), EKI will collect subslab soil vapor samples at nine sample locations at Building 937 in accordance with the field methods and procedures outlined in Attachment A and as specified in Standard Operating Procedures ("SOP") SOP 11, SOP 014, and SOP 015 of the QAPP (included as part of Attachment A). Samples will be collected within the footprint of the former tank excavation in the northeastern corner of Building 937 and will fan out away from the source area to the southwest. Sample identifications are based on "937" for Building 937, "VS" for vapor sample, "IA" for indoor or ambient air sample, and sequential numbers starting at 101. Two subslab soil vapor samples will be collected near the northeastern corner wall where residual chemicals could not be removed during remedial actions (937VS101 and 937VS102), with three additional samples taken to the west, south, and southeast of the former Army excavation area in the northeastern corner of the building (937VS107, 937VS109, and 937VS103). A sample will be taken near the centrally located floor drain (937VS104), and two samples will be taken in the opposite corner of the building from the former tank excavation (937VS105 and 937VS106). Further, a sample (937VS108) will be collected near the former location of UST 937.H, a tank associated with a former hydraulic lift. Proposed subslab soil vapor sampling locations are shown on Figure 1.

Subslab vapor samples will be collected in 6-liter SUMMA canisters and analyzed for the full scan of volatile organics with tentatively identified compounds ("TICs") by US EPA Method TO-15 for quantitative results. If detection limits for Method TO-15 are elevated above concentrations needed to determine human health risks, samples will be reanalyzed using Method TO-15 with Selected Ion Monitoring ("SIM") to achieve detection limits to perform the risk calculation. Samples will be collected over approximately 20 minutes or as reasonable to fill the SUMMA canister. Specific field methods and procedures for subslab soil vapor sampling are included in Appendix A. In accordance with DTSC's request, samples will be collected as closely as possible to a rising tide or high tide in order to sample during potential periods of maximum subslab vapor gas concentrations.[1]

Per DTSC request, on the date of subslab vapor gas sampling, the three groundwater monitoring well points within Building 937 will be opened and the well headspace screened for total VOC content using a Photoionization Detector ("PID").[2] The monitoring wells will be closed and no groundwater samples will be collected. While the vapors in the well headspace provide information about the equilibrium between groundwater and the headspace of the well, these groundwater well headspace values will not be used to calculate potential human health risks.

In accordance with the DTSC vapor intrusion guidance, a second round of subslab vapor samples will be collected approximately three months after the first sampling event to evaluate potential seasonal variations in the sampling results.

General Field Procedures for Collection of Indoor and Ambient Air Samples

As described above, indoor air sampling will be conducted if subslab samples indicate a potential human health risk. If indoor air sampling is determined to be necessary, then indoor air sample locations will be proposed by the Trust based on the subslab vapor sampling data and presented to the DTSC and the other stakeholders for review and concurrence. As part of the indoor air sampling program, ambient air samples will also be collected to assess background concentrations of the COCs in ambient air.

If collected, indoor and ambient air samples will be collected as soon as reasonably possible after review of each round of subslab vapor sample results. In accordance with DTSC guidance, indoor air and ambient air samples will be collected in SUMMA

---

[1] On the currently proposed sampling date, 1 December 2005, high tide at the Golden Gate Bridge is predicted to occur at approximately 11:00 AM, which, allowing for some attenuation of the tidal impact to groundwater over the 450 from the Bay, should result in most sampling occurring on a rising tide. Additionally, tide height is predicted to be over six feet, which should also result in the sampling occurring during maximum or near-maximum subslab soil vapor gas compression beneath the building. EKI is not aware that a direct link between tidal variations, groundwater elevation, or subslab vapor pressure at Building 937 has been documented.

[2] Trust documents indicate 937WP02 may have been abandoned; on the sampling date this well will be examined, and the headspace will be screened if the well has not been abandoned.

canisters and will be analyzed by US EPA Method TO-15 only for chemicals detected in the subslab vapor. Analysis is planned to include SIM so detection limits will be lower than the risk-based target concentrations for indoor air. Indoor air samples will be collected over an 8-hour period to reflect the commercial exposure scenario. The chemical concentrations measured over the 8-hour period are expected to be representative of the concentrations that would be present during a 3-hour recreational exposure time. Ambient air samples will also be collected over an 8-hour period, but they will be staggered to initiate collection one to two hours before indoor air samples and terminated before the indoor air samples.

If indoor air sampling is necessary, indoor air samples will likely be collected at three locations within Building 937 and two locations outside the building. Potential indoor air samples are shown on Figure 1. However, these locations will be reevaluated based on the subslab vapor data, and will be discussed with DTSC prior to implementing the indoor air sampling event. Indoor air samples will likely be collected near the northeastern wall by the former excavation area, near the central floor drain, and in the southwestern portion of the building. Sample inlets will be approximately three feet above the floor. Ambient air samples will be collected outside the building near the former concrete ramp structure at the northwestern corner of the building and near the roll-up doors at the northeastern corner of the building. The ambient air sampling locations were selected to be in the general upwind direction of the building and to avoid physical features such as other buildings and hillsides that could block wind on the sides of the building, as recommended in the DTSC guidance. Wind direction will be assessed on the day of sampling and ambient air locations may be adjusted, if necessary, so that the sample locations are generally upwind of the building throughout the sample collection period.

If the second round of subslab vapor sampling (collected approximately 3 months after the first sampling event) indicates potential human health risks are present then indoor and ambient air sampling will be conducted shortly after the subslab vapor sampling.

Field Quality Control Samples

Field duplicates will be collected as part of this investigation. A field duplicate is a sample collected at the same time, and from the same source and depth as the associated primary sample. Field duplicate pairs are collected to assess the consistency or precision of the laboratory's analytical system. The QAPP specifies a frequency of ten percent for field duplicates; therefore, one field duplicate sample will be collected and submitted to the laboratory for analysis for each round of subslab sampling as well as indoor air sampling, if performed.

As described in Appendix A, a trip blank will be submitted for indoor air sampling only.

LABORATORY ANALYSIS AND ANALYTICAL METHODS

The subslab soil gas vapor samples and air samples will be analyzed by K Prime of Santa Rosa, California, a State-certified analytical laboratory, on a standard turnaround time basis. For each round of sampling, K Prime will analyze nine subslab soil vapor samples and 1 quality assurance/quality control (QA/QC) duplicate sample to be collected in accordance with the Presidio QAPP, as described above. If air sampling is determined to be necessary, K Prime will analyze the air samples (expected to be approximately five) plus a duplicate and trip blank for each round of sampling.

The subslab samples and indoor/ambient air samples (if collected) will be analyzed by EPA Method TO-15, with SIM (if necessary to achieve detection limits to perform the risk calculation). The indoor and ambient air samples will only be analyzed for constituents detected in the subslab vapor samples.

The analytical quality control criteria are provided in the QAPP. Analytical data will be validated by DataVal, Inc.

CALCULATION OF POTENTIAL HUMAN HEALTH RISKS

The results of the subslab vapor sampling events will be used to calculate potential risks to future commercial/industrial workers and adult, teenage, and child recreational receptors using the pathways and assumptions presented in Tables 2 and 3. The general approach to calculate risks will be as follows:

(1) Develop chemical-specific risk-based target concentrations for indoor air ("$RBTC_{IA}$") for each chemical detected in the subslab soil gas samples. The RBTCs will correspond to a target lifetime incremental cancer risk of 10^{-6} and / or a target Hazard Index of one.

(2) Divide the $RBTC_{IA}$ by an attenuation factor of 0.01 to calculate the equivalent RBTC for subslab soil vapor ("$RBTC_{SS}$").

(3) Calculate cumulative risks for each population by summing the ratio of the maximum subslab soil gas concentration with its respective $RBTC_{SS}$ for carcinogenic and non-carcinogenic COCs. For carcinogens, the summed ratio for each population will be multiplied by 10^{-6} to calculate estimated lifetime incremental cancer risks. For non-carcinogens, the summed ratio for each population will equal the total estimated Hazard Indices.

These steps are described in more detail below.

Development of Risk-Based Target Concentrations for Indoor Air

For each chemical detected in subslab soil vapor samples, chemical-specific risk-based target concentrations for indoor air for cancer risks ("$RBTC_{IA\text{-}c}$") in units of $\mu g/m^3$ will be calculated according to the following equations:

$$RBTC_{IA\text{-}c} = \frac{\text{Target Risk Level of } 10^{-6}}{CSF \times CF \times (\text{Inhalation}_{child} + \text{Inhalation}_{adult})}$$

where "CSF" is a chemical-specific carcinogenic potency factor for exposure through inhalation, and "CF" is a conversion factor of 10^{-3} mg/µg. The inhalation exposure to COCs for various children and adult populations at Building 937 are estimated with the following equations:

$$\text{Inhalation}_{child} = \frac{IR_{child} \times ET \times EF \times ED}{BW_{child} \times AT}$$

$$\text{Inhalation}_{adult} = \frac{IR_{adult} \times ET \times EF \times ED}{BW_{adult} \times AT}$$

where "IR_{child}" and "IR_{adult}" are the applicable Inhalation Rates for children and adults, respectively, "ET" is Exposure Time; "EF" is Exposure Frequency; "ED" is Exposure Duration; "BW_{child}" and "BW_{adult}" are the applicable Body Weights for children and adults, respectively; and "AT" is averaging time. Collectively, these parameters are referred to as Exposure Factors and specific values for the scenarios evaluated at Building 937 are presented in Table 3. The appropriate values should be substituted into the equations to calculate $RBTC_{IA\text{-}c}$ values for the recreational, teenage recreational, and commercial-industrial exposure scenarios.

For non-carcinogenic COCs, risk-based target concentrations for indoor air ("$RBTC_{IA\text{-}nc}$") will be calculated with the following equation:

$$RBTC_{IA\text{-}nc} = \frac{RfD \times \text{Target HI of } 1}{(\text{Inhalation}_{child})}$$

where "HI" is the Hazard Index, a method of quantifying the degree of chemical exposure below which it is unlikely for even sensitive populations to experience adverse health effects and "RfD" is the chemical-specific inhalation Reference Dose. As above for carcinogens, the appropriate values should be substituted into the equations to calculate $RBTC_{IA\text{-}nc}$ values for the recreational, teenage recreational, and commercial-industrial exposure scenarios.

Carcinogenic slope factors ("CSFs") and non-carcinogenic reference doses ("RfDs") used in the above equations will be obtained from the following hierarchy of regulatory sources as described in the Cleanup Level Document (EKI, 2002), which is generally consistent with California Human Health Screening Levels ("CHHSLs"):

- Cal/EPA OEHHA Toxicity Criteria Database, dated 10 August 2005.
- U.S. EPA's computerized Integrated Risk Information System ("IRIS").
- U.S. EPA's Health Effects Assessment Summary Tables ("HEAST"), dated July, 1997.
- U.S. EPA's National Center for Environmental Assessment ("NCEA"), Draft Risk Assessment Issue Papers for individual chemicals.

Development of Risk-Based Target Concentrations for Subslab Soil Vapor

As recommended in the DTSC Vapor Intrusion Guidance (DTSC, 2004), a soil attenuation factor of 0.01 (Dawson, 2004) will be used to convert RBTCs for indoor air into equivalent RBTCs for subslab soil vapor. The equation to perform this conversion is as follows:

$$\mathrm{RBTC}_{SS} = \frac{\mathrm{RBTC}_{IA}}{0.01}.$$

Calculation of Cumulative Human Health Risks

The chemical-specific risks and HIs due to vapor intrusion from subslab soil gas will be calculated for each population by summing the ratio of the maximum subslab soil gas concentration with its respective RBTC_{SS} for carcinogenic and non-carcinogenic COCs. For carcinogens, the summed ratio for each population will be multiplied by 10^{-6} to calculate estimated lifetime incremental cancer risks. For non-carcinogens, the summed ratio for each population will equal the total estimated Hazard Indices.

The equation for calculating the estimated lifetime incremental cancer risk for each population is as follows:

$$\mathrm{Risk}_{\mathrm{population}} = \sum \frac{C_{SS-i} \times 10^{-6}}{\mathrm{RBTC}_{SS-c-i}}$$

where C_{SS-i} is the maximum concentration of carcinogenic chemical "i" in the subslab soil gas samples and RBTC_{ss-c-i} is the risk-based subslab carcinogenic target concentration for that chemical "i".

Similarly, the total Hazard Index ("HI") for each population is as follows:

$$HI_{population} = \sum \frac{C_{SS-i}}{RBTC_{SS-nc-i}}$$

where C_{SS-i} is the maximum concentration of non-carcinogenic chemical "i" in the subslab soil gas samples and $RBTC_{ss-nc-i}$ is the risk-based subslab non-cancer target concentration for that chemical "i".

If a calculated hypothetical health risk at a given sampling location is equal to or less than a cumulative lifetime incremental cancer risk of one-in-one million (10^{-6}) or a total HI is equal to or less than one, then indoor/ambient air sampling will not be performed.

If indoor air sampling is determined to be necessary, the results of the indoor and ambient air sampling event will be used to calculate potential risks, using the equations and methods described above. No soil vapor to indoor air attenuation factor will be needed for these calculations, as direct indoor air measurements will be used. The indoor air risks will be compared with the risks calculated for ambient air and the ratios of the compounds detected in subslab soil gas and indoor air will be assessed. Together, this information will be used to determine if the constituents and levels detected in indoor air are representative of ambient air or other potential sources and to evaluate the significance of the indoor air risk. This information will be used to determine if mitigation measures are necessary to reduce potential risks to future building occupants.

SCHEDULE

EKI recognizes that the schedule of this sampling event is important to the Trust for leasing purposes. Field activities will commence upon stakeholder approval of this Field Sampling Plan. For planning purposes, EKI anticipates subslab vapor sampling will be performed on 1 December 2005, assuming stakeholder approval is obtained by 19 November 2005. It is anticipated that the subslab soil vapor sampling events can be completed in one day. Upon receipt of the laboratory data, EKI will review the data and calculate potential human health risks. EKI will provide the Trust with a summary of potential health risks within two weeks of the receipt of the laboratory data.

If the results indicate that no indoor air sampling is necessary, the EKI will notify the Trust and the Trust will notify stakeholders of the results. If indoor air sampling is recommended, the Trust will schedule a conference call with the stakeholders to discuss the existing data and agree upon air sampling locations and chemical parameters to be evaluated.

The second subslab vapor sampling event will be scheduled approximately three months after the first round of subslab sampling. The Trust will provide advance notice to the stakeholders of the sampling date. The same process of reviewing the results will be conducted as described above for the first sampling event.

EKI will prepare a sampling report after receipt of the validated analytical data from the second subslab vapor sampling event or air sampling event, if necessary.

Please contact us at (650) 292-9100 if you have any questions or comments.

Very truly yours,

John T. DeWitt, P.E.
Project Engineer

Michelle K. King, Ph.D.
Project Manager

Attachments

Table 1 – Building 937 Data Quality Objectives
Table 2 – Exposed Populations and Exposure Pathways for Building 937 Indoor Air Evaluation
Table 3 – Exposure Factors Used to Calculated Hypothetical Human Health Risk for Indoor Air at Building 937

Figure 1 – Building 937 Subslab Vapor and Indoor Air Sampling Locations

Attachment A – Field Methods and Procedures for Subslab Soil Vapor Sampling and Indoor Air and Ambient Air Sampling
Figure A-1 – Subslab Soil Vapor Sampling Configuration

References

Dawson, Helen, 2004. *Comments on Empirical Data/Methods*. Presentation at the 14th Annual West Coast Conference on Soils, Sediments, and Water, Association of Environmental Health and Science; Vapor Intrusion Attenuation Workshop sponsored by the United States Environmental Protection Agency. San Diego, California. March 15-18.

DTSC, 2004. *Interim Final Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air*. December. Revised Feb. 7, 2005.

EKI, 2002. *Development of Presidio-Wide Cleanup Levels for Soil, Sediment, Groundwater, and Surface Water, Presidio of San Francisco, California.* October.

EKI, 2004. *Crissy Field Operable Unit 4 Implementation Report, Presidio of San Francisco, California.* July.

IT Corporation, 1998. *Soil Remediation Closure Report, Crissy Field Area, Presidio of San Francisco, California.* June.

Tetra Tech, 2001. *Presidio-Wide Quality Assurance Project Plan, Sampling and Analysis Plan, Presidio of San Francisco, California.* April.

Treadwell & Rollo, 2003. *Draft Building 900s Area Construction Completion Report.* March.

US EPA, 2002. *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance).* November.

Watkins-Johnson, 1993. *Soil and Groundwater Pollution Characterization Report for Building 937, Presidio of San Francisco.* September.

TABLE 1 - BUILDING 937 DATA QUALITY OBJECTIVES

Presidio of San Francisco, California

State the Problem	Identify the Decisions	Identify Inputs to the Decisions	Define the Study Boundaries	Develop Decision Rules	Specify Limits on Decision Errors	Optimize the Design
Ethylbenzene and petroleum hydrocarbons ("TPH") have been detected in soil and TPH in groundwater at or above applicable Crissy Field RAP cleanup levels at the northeastern corner of Building 937. Benzene, toluene, ethylbenzene, and xylenes have been detected in soil samples at levels that are slightly greater RWQCB Environmental Screening Levels in indoor air for commercial receptors. Therefore, there is a potential for indoor air exposure to petroleum hydrocarbons and volatile organic compounds ("VOCs"). Two former underground storage tanks (937.1 and 937.2) in the northeastern corner of the building that were used by the Army to store xylenes and waste oil are believed to be the primary source of residual petroleum hydrocarbons and VOCs in soil and groundwater in the Building 937 Area. The Army removed the tanks and performed remedial actions; however, impacted soil near the building foundation could not be removed without compromising the building's structural integrity. There were also a former hydraulic lift and associated UST (UST 937.H) in the southeastern portion of Building 937 where petroleum hydrocarbons were reportedly observed in soil. The Trust plans to lease Building 937 to tenants for recreational/commercial use. DTSC has expressed concern that residual chemicals in soil and groundwater may be a source of volatile chemicals into the indoor air of the building. This sampling program is proposed to evaluate whether residual subsurface chemicals pose a significant risk to future recreational or commercial building occupants through the indoor air exposure pathway.	1. Are residual petroleum hydrocarbons and VOCs from previous Army impacts present in the subslab vapor below Building 937? 2. If residual petroleum hydrocarbons and VOCs are present in the subslab vapor, are they present at concentrations that are potentially a significant risk (i.e., greater than 10^{-6} lifetime incremental cancer risk or a cumulative noncancer hazard index ("HI") >1)? 3. If petroleum hydrocarbons and VOCs are present in subslab vapor, are these same chemicals also present in indoor air? 4. If petroleum hydrocarbons and VOCs are present in indoor air, is there a geographic distribution of the concentrations within the building? 5. Are the petroleum hydrocarbons and VOCs detected in the subslab vapor and indoor air samples also present in ambient air samples? 6. Are petroleum hydrocarbons and VOCs present in indoor air at concentrations that pose a significant risk relative to ambient air and background (e.g., non-subsurface contributions), as shown in the table in Contingency Planning section of the DTSC Guidance (Step 8, page 29)? 7. If petroleum hydrocarbons and VOCs are present in subslab vapor and indoor air, are mitigation measures appropriate to reduce the potential risk for the building occupants?	1. Results of previous chemical analysis of soil and groundwater samples. 2. Results of chemical analysis from 2 rounds of subslab vapor samples collected 3 to 6 months apart. 3. Results of chemical analysis of indoor air samples (including ambient samples), if collected. 4. DTSC Guidance (e.g., subslab vapor intrusion factors in Step 6 and potential response actions to be taken from the table in Contingency Planning section of Step 8).	The study boundaries for the subslab investigation are within the footprint of Building 937. If indoor air samples are collected, the samples will be collected within Building 937 and outside of the building at locations representative of ambient conditions, in accordance with the DTSC Guidance.	1. If the detected chemical concentrations in subslab vapor samples result in a calculated cumulative risk associated with vapor intrusion above 10^{-6} or a HI= 1, the Trust will collect indoor air samples. Otherwise, indoor air samples will not be collected, and no significant risk will be attributable to residual subsurface chemicals. Potentially exposed populations and exposure assumptions to assess vapor intrusion risks are presented in the attached Tables 2 and 3. 2. Per DTSC Guidance, if indoor air samples are collected, the indoor air samples (and associated ambient samples) will only be analyzed for those chemicals detected in subslab vapor analyses. 3. If indoor air samples are to be collected, the samples will be collected as soon as possible after the subslab vapor sample results are available and have been evaluated. 4. If indoor air samples are collected, to achieve the DTSC Guidance recommendation for analyses over seasonal differences, a second round of indoor air samples will be collected within 3 to 6 months after the initial sample. 5. Per U.S. EPA Guidance, the ratios of VOCs in indoor air samples will be compared to the ratios of the same VOCs in subslab vapor samples to distinguish subsurface-derived VOCs from non-subsurface sources (i.e., indoor air and ambient air sources). If these ratios are different then the VOCs in indoor air are not originating from the subslab vapor (i.e., vapor intrusion is not a complete pathway) and those chemicals will not be included in the evaluation of risk due to vapor intrusion. 6. The risks of chemicals detected in ambient air samples and indoor air samples will be calculated. The risk associated with chemicals in ambient air will be included in the assessment of the significance of indoor air risk.	1. Field, analytical, and data validation procedures will follow the QAPP (Tetra Tech, 2001), as modified to follow DTSC Guidance. Duplicate samples (subslab and indoor air) will also be collected per the QAPP. 2. If no chemicals on the analyte list are detected in any of the indoor air samples or ambient air samples from a single round, the Trust will discuss the results with the laboratory and ascertain if other VOCs were detected but not reported by the laboratory. If no VOCs were detected, in keeping with the DTSC Guidance, the data will be rejected and the sampling event repeated.	Building 937 is approximately 110' x 160', with no interior walls, with open rafters allowing ventilation through roof vents. The Trust understands that tenants will subdivide into several large spaces. 1. Nine subslab vapor samples will be collected from locations below Building 937, as shown on Figure 1. Subslab vapor sample locations will be oriented based on known data from the building history. Samples will be collected from above the backfill of the former tank excavation in the northeastern corner of the Building 937, and will fan out away from the source area to the southwest. Two samples will be collected near the northeastern corner wall where residual chemicals could not be removed during remedial actions. Another sample will be collected near the centrally located floor drain, in accordance with DTSC Guidance. Three more samples will be collected around the edges of the excavation limit. Two more samples will be collected in the southwestern portion of the building, and one sample will be collected near the former hydraulic lift. Subslab vapor samples will be collected in SUMMA canisters and analyzed for the full scan of volatile organics with tentatively identified compounds ("TICs") by US EPA Method TO-15 for quantitative results. Samples will be collected over approximately 20 minutes or as reasonable to fill the SUMMA canister. 2. Indoor air samples, if collected, will be collected as soon as reasonably possibly after review of subslab vapor sample results. Indoor air samples and ambient samples will be collected in SUMMA canisters and will be analyzed by US EPA Method TO-15 only for chemicals detected in the subslab vapor, in accordance with the DTSC Guidance. Indoor air samples will be collected over an 8-hour period to reflect the commercial and recreational (i.e., non-residential) exposure scenarios. Ambient air samples will be staggered to initiate collection 1 to 2 hours before indoor air samples, and terminate collection approximately 30 minutes before the indoor air samples, per the DTSC Guidance. Indoor air sampling will be conducted at 3 locations within Building 937 and 2 locations outside the building (see Figure 1). Potential indoor air samples will be collected near the northeastern wall by the former excavation area, near the central floor drain, and in the southwestern portion corner of the building. Sample inlets will be approximately 3 feet above the floor. Ambient air samples will be collected outside the building near the former concrete ramp structure at the northwestern corner of the building, and near the roll up doors at the northeastern corner of the building. The ambient air sampling locations were selected to be upwind of the building and to avoid physical features such as other buildings and hillsides that could block the wind on the sides of the building, as recommended by the DTSC Guidance.

Abbreviations:

DTSC	Department of Toxic Substances Control, California Environmental Protection Agency
DTSC Guidance	*Interim Final, Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air*, DTSC, dated 7 February 2005.
HI	Hazard Index
QAPP	*Presidio-Wide Quality Assurance Project Plan, Sampling and Analysis Plan*, Tetra Tech EM Inc., dated April 2001.
RWQCB	Regional Water Quality Control Board
TPH	total petroleum hydrocarbons
U.S. EPA Guidance	*Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)*, U.S. Environmental Protection Agency, dated November 2002.
VOCs	volatile organic compounds

TABLE 2
EXPOSED POPULATIONS AND EXPOSURE PATHWAYS FOR BUILDING 937 INDOOR AIR EVALUATION

Presidio of San Francisco, California

Potentially Exposed Populations and Significant Exposure Pathways	Rationale
Residential Use (Children & Adults)	
• None	The Trust has implemented a land use control prohibiting residential use at Building 937. Thus, no residential exposure scenarios are considered.
Recreational Use (Children, Teenagers, and Adults)	
• Inhalation of VOCs in Indoor Air	Children and adults visiting Building 937 may be exposed to volatile organic compounds ("VOCs") that have migrated from the subsurface into indoor air. Currently, potential tenants are considering a café/restaurant and a sports equipment rental facility for Building 937. The exposure scenario assumes that an adult brings a child to the café for 3 hours 3 days per week (similar to 1-2 hours per day, 5 days per week). Consistent with the Presidio-wide Cleanup Level Document, recreational exposure is assumed to occur for 6 years as a child and 24 years as an adult. In the event that Building 937 is converted into another recreational use area, such as a gymnasium, the potential exposure of a teenager participating in an indoor sport (e.g., basketball) inside Building 937 was evaluated. The teenager is assumed to have practices 3 hours per day, 5 days per week, 50 weeks per year. The active teenage breathing rate is assumed to be greater than the average recreational and commercial/industrial breathing rate for adults. In the Trust's Cleanup Level Document, recreational users of the Presidio were generally assumed to be primarily outdoors. Therefore, vapor intrusion of VOCs to indoor air was considered to be an incomplete pathway. This evaluation at Building 937 is a special condition of the recreational user.
Commercial/Industrial Use (Adults)	
• Inhalation of VOCs in Indoor Air	Inhalation of VOCs from vapor intrusion to indoor is considered a complete pathway. Commercial/industrial exposure assumes 5 days per week for 25 years. The commercial/industrial exposure scenario also represents a conservative assessment of an adult recreational user of a gymnasium who may exercise 2 to 3 hours per day, 5 days per week for 25 years.

TABLE 3
EXPOSURE FACTORS USED TO CALCULATE HYPOTHETICAL HUMAN HEALTH RISK FOR INDOOR AIR AT BUILDING 937

Presidio of San Francisco, California

Exposure Parameter	Units	Default or Assumed Value	Reference (a)
Averaging Time (AT)			
Carcinogenic	days	27,375	U.S. EPA, 1997
Non-carcinogenic			
Recreational	days	2,190	U.S. EPA, 1991; DTSC, 1996
Teenage Recreational	days	2,190	Professional Judgment
Commercial/Industrial	days	9,125	U.S. EPA, 1991; DTSC, 1996
Exposure Frequency (EF)			
Recreational -- Child and Adult	days/year	150	Professional Judgment
Recreational -- Teenager	days/year	250	Professional Judgment
Commercial/Industrial	days/year	250	U.S. EPA, 1991; DTSC, 1996
Exposure Duration (ED)			
Recreational			
Carcinogenic	years	6 (child) + 24 (adult)	U.S. EPA, 1991; DTSC, 1996
Non-carcinogenic	years	6 (child)	U.S. EPA, 1991; DTSC, 1996
Teenage Recreational			
Carcinogenic and Non-carcinogenic	years	6 (jr. high/high school)	Professional Judgment
Commercial/Industrial			
Carcinogenic and Non-carcinogenic	years	25	U.S. EPA, 1991; DTSC, 1996
Body Weight (BW)			
Adult	kg	70	U.S. EPA, 1991; DTSC, 1996
Child	kg	15	U.S. EPA, 1991; DTSC, 1996
Teenager	kg	45	U.S. EPA, 1997 (b)
Air Inhalation Rate (IR)			
Adult - Recreational	m^3/hr	1.6	U.S. EPA, 1997 (c)
Child - Recreational	m^3/hr	1.2	U.S. EPA, 1997 (c)
Teenager - Recreational	m^3/hr	1.9	U.S. EPA, 1997 (d)
Adult - Commercial/Industrial	m^3/d	14 (equivalent to 1.75 m^3/hr)	U.S. EPA, 1997 (e)
Exposure Time (ET)			
Adult - Recreational	hr/d	3	Professional Judgment
Child - Recreational	hr/d	3	Professional Judgment
Teenager - Recreational	hr/d	3	Professional Judgment
Attenuation Factor (α)	-	0.01	DTSC, 2005 (f)

TABLE 3
EXPOSURE FACTORS USED TO CALCULATE HYPOTHETICAL HUMAN HEALTH RISK FOR INDOOR AIR AT BUILDING 937

Presidio of San Francisco, California

Notes:

(a) References for exposure parameter values are as follows:

- U.S. EPA. 25 March 1991. *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Supplemental Guidance, Standard Default Exposure Factors.* Interim Final. OSWER Directive 9285.6-03.
- U.S. EPA. August 1997. *Exposure Factors Handbook Volume I General Factors: Principles and Applications.* Office of Research and Development. EPA 600/P-95/002F.
- DTSC. August 1996. *Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities*.
- DTSC. February 2005. *Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air*.

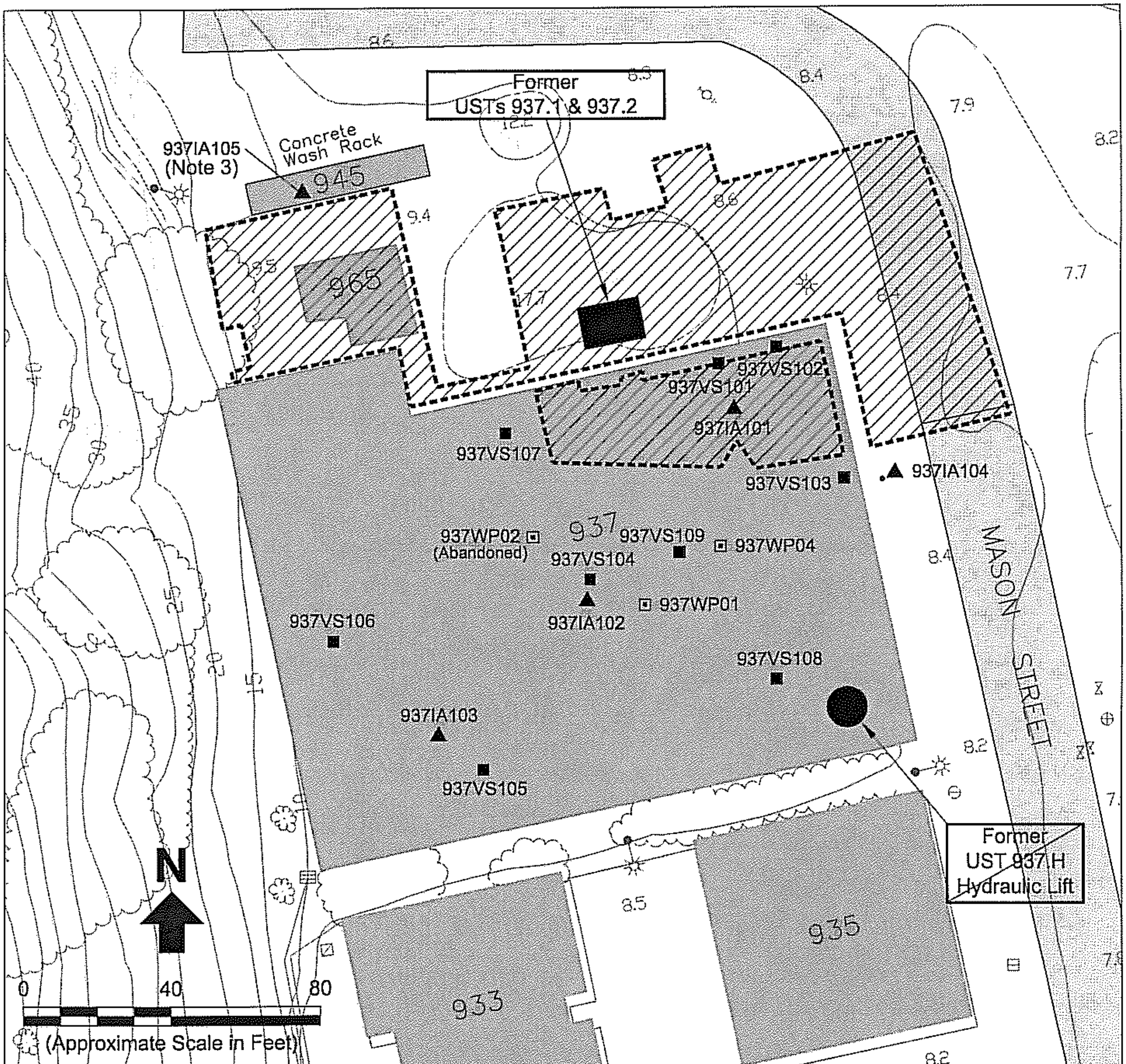
(b) Teenage body weight is based on mean for boys and girls aged 12 years, Table 7-3 from U.S. EPA 1997.

(c) Inhalation rate based on moderate activity, Table 5-23 from U.S. EPA 1997.

(d) Teenage inhalation rate based on heavy activity, Tables 5-23 and 5-27 from U.S. EPA 1997.

(e) Commercial inhalation rate assumes a "moderate industrial job" with a daily work inhalation rate calculated based on approximately 2 hours of light activity, 4 hours of moderate activity, and 2 hours of heavy activity. References: U.S. EPA 1997 and personal communication with Dr. Kimiko Klein, DTSC.

(f) Attenuation factor from subslab into indoor air from DTSC, 2005, as supported by documentation from Helen Dawson of the U.S. EPA.

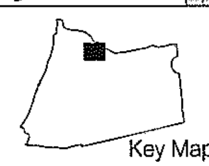


LEGEND

- Former AST or UST Location
- Former Army Excavation Areas
- 937 Existing Building
- Well Point
- Subslab Vapor Sample Location
- Potential Air Sample Location

Abbreviations:

UST = underground storage tank



Notes:

1. All locations are approximate.
2. Basemap provided by the Presidio Trust.
3. Locate sampler on top of existing concrete platform.
4. If air sampling is needed, air sample locations will be selected in consultation with DTSC.

Erler & Kalinowski, Inc.

Building 937
Subslab Vapor and Indoor Air Sampling Locations

Presidio Trust
San Francisco, CA
October 2005
EKI A000003.08

Figure 1

APPENDIX A

FIELD METHODS AND PROCEDURES FOR SUBSLAB SOIL VAPOR SAMPLING AND INDOOR AND AMBIENT AIR SAMPLING

Building 937, Presidio of San Francisco, California

<u>A-1 Subslab Soil Vapor Sampling</u>

Nine subslab soil vapor samples will be collected inside Building 937 for each round of sampling. To collect subslab soil vapor samples from beneath the interior slab, a small diameter hole (approximately 1-inch in diameter) will be drilled through the concrete in two stages. The first stage involves drilling a 1-inch diameter core hole 4 to 5-inches deep. The depth of the initial hole is intentionally selected to be slightly less than the full thickness of the slab. After the core is removed, cooling water that will have been introduced during coring will be removed using paper towels and a shop vacuum. Once the hole is dry, a Roto-hammer with a ¾-inch bit will be used to penetrate the remaining concrete (usually 1 to 2-inches). As soon as the slab is breached, the Roto-hammer bit will be removed and dust vacuumed out of the hole for 3 to 5 seconds. A rubber stopper with tubing connected to the SUMMA canister purging/sampling train will be quickly inserted as shown on Figure A-1. Subsurface conditions will be allowed to equilibrate for approximately 30 minutes before sampling.

Sampling will be accomplished using a sampling train that incorporates a laboratory-supplied 6-liter SUMMA canister, a vacuum tight valve, vacuum gauges, a 200 milliliter per minute flow controller, and an in-line particle filter connected with disposable Teflon tubing (Figure A-1). The soil vapor sample for volatile organic compounds ("VOCs") will be collected in the sample SUMMA canister. During sampling leak detection compounds, such as 1,1-difluoroethane or tetrafluoroethane, which are found in "dust-off" sprays, will be regularly discharged around all tubing joints where leakage of ambient air into the system could potentially occur. These compounds were selected as the leak detection compounds because they are non-toxic gases that are easily identifiable during analysis and do not occur at contaminated sites. Therefore, it does not interfere with the quantitative analysis of VOCs.

Each SUMMA canister will be individually certified as clean by the laboratory prior to use in the field. Once collected, each subslab soil vapor canister will be labeled and transported to the laboratory in accordance with the Quality Assurance Project Plan ("QAPP").

The slab penetration will be filled with grout and a concrete patch at the conclusion of sampling.

In addition to sampling of the subslab vapor, screening of the headspace of the three groundwater monitoring wells within Building 937 has been requested by DTSC.[1] This screening of the groundwater monitoring well headspace will be done using a photoionization detector ("PID") in accordance with section B4.2.1 of the QAPP that describes PID screening procedures. The subslab vapor sample points will be screened in a similar fashion after the sample is collected.

A field duplicate for quality assurance/quality control ("QA/QC") analysis will be taken at 937VS101.

A-2.0 Air Sampling

If results from subslab vapor samples indicate a potential human health risk, indoor and ambient air samples will be collected. Air samples will be collected in six-liter SUMMA canisters. When the sampling canisters are requested from the laboratory, the sampling duration will be specified so that the laboratory can pre-set the flow controller rates. By providing the appropriate pressure to the laboratory, the laboratory can simulate the proper pressure and set flow controllers accordingly. A fixed-flow controller is set to collect 5 liters (L) of sample over the time interval so that a net negative pressure is maintained in the canister. The flow rate for a 6-L canister collecting an 8-hour composite sample would be approximately 13.35 milliliters per minute.

Per Department of Toxic Substances Control ("DTSC") guidance, a trip blank will be submitted for each day of air sampling. An extra evacuated canister will be sent from the laboratory with the canisters in which the air samples will be collected. The trip blank canister will be placed in the building when the other air samples are being collected, but it will remain under vacuum and will be filled by the laboratory after the return of the now full sample canisters. Although the DTSC guidance requires a trip blank, if the trip blank canister fails (i.e., if compounds are detected in the trip blank), it will indicate that the vacuum was fully not maintained on that particular canister; it will not necessarily indicate that any of the other sample canisters have failed.

A-2.1 Indoor Air Sampling

Since the Trust intends to lease Building 937 to commercial interests, the indoor air samples will be collected over an eight-hour period, assuming the calculated human health risk to recreational populations or commercial workers exceeds a cumulative lifetime incremental cancer risk of 10^{-6} or total hazard index of one in the subslab sampling event. Sample locations will be selected based on the subslab sample results, and as discussed with DTSC representatives. Building 937's ventilation and heating systems are not currently operational, so in accordance with the DTSC guidance, the building will be sampled as a sealed building without either system running.

[1] Treadwell and Rollo identify 937WP02 as abandoned in the Draft Building 900s Construction Completion Report. If the well is abandoned, then the headspace of only two wells will be sampled.

A duplicate indoor air sample will collected at the sample location nearest the area of expected highest VOC concentration.

A-2.2 Ambient Air Sampling

Ambient air samples will be collected in order to provide verification that the laboratory is able to detect low ambient levels of COCs and to help determine how sources outside of Building 937 may impact indoor air quality. Samples will likely be collected near the roll up door of the building as well as at the existing concrete wash rack located north of the building. The samplers will be secured or monitored to prevent disturbance over the course of the sampling period.

Per DTSC guidance to reflect the source air for the building, collection of the two ambient air samples will begin one to two hours before initiation of indoor air sampling. The ambient air samples will also be collected over an eight-hour period.

A-3.0 Disposal of Investigation-Derived Wastes

Wastes generated during the investigations at Building 937 will include concrete cuttings and cooling water used during concrete boring, as well as gloves and other personal protective equipment. Since neither cooling water nor concrete will have been in contact with contaminated soil, these wastes may be disposed as non-hazardous debris in regular trash. Any other wastes generated during the sampling event will only be exposed to limited vapor concentrations which are not likely to contain chemicals of concern. Therefore, no hazardous waste residuals are expected from the sampling event.

SOP APPROVAL FORM

THE PRESIDIO TRUST
ENVIRONMENTAL STANDARD OPERATING PROCEDURE

SOIL GAS SAMPLING METHODS

SOP NO. 011
REVISION NO. 00

Last Reviewed: December 2000

Quality Assurance Approved

12 Jan 01
Date

1.0 BACKGROUND

Soil gas samples are collected in environmental investigations to assess the vapor phase of contaminants in the vadose zone (soil gas) or other gaseous constituents of interest. Soil gas samples can be collected using several methods. This standard operating procedure (SOP) presents sample collection procedures for collecting soil gas samples in Tedlar® bags, glass sampling bulbs, and stainless-steel canisters. Tedlar® bags and glass sampling bulbs are best suited for on-site or near-site chemical analysis, whereas steel canisters are best suited for shipping samples to a full service laboratory.

1.1 PURPOSE

The purpose of this SOP is to provide guidance for the use of Tedlar® bags, glass sampling bulbs, and stainless-steel canisters for soil gas sample collection. Soil gas samples collected by these methods may be analyzed for volatile organic compounds (such as trichloroethene, benzene, and toluene) and for inorganic parameters (such as nitrogen, oxygen, and carbon dioxide).

1.2 SCOPE

This SOP applies to all personnel collecting soil gas samples in Tedlar® bags, glass sampling bulbs, or stainless-steel canisters. The site-specific work and sampling plans should be followed during soil gas sampling activities.

1.3 DEFINITIONS

Soil Gas: The gases or atmosphere filling the void spaces in soils and unconsolidated sediments. These gases may all be of natural origin, but manmade contaminants or by-products may be present in detectable quantities.

Tedlar® Bag: Inflatable bag manufactured from proprietary non-reactive synthetic material impermeable to gases.

1.4 REFERENCES

American Society for Testing Materials (ASTM). 1993. "Standard Guide for Soil Gas Monitoring in the Vadose Zone." *Environmental Standards on Environmental Sampling*. Second Edition. 1997. ASTM D 5314–92. January.

U.S. Environmental Protection Agency (EPA). 1984. *Characterization of Hazardous Waste Sites – A Methods Manual: Volume II, Available Sampling Methods.* Second Edition. EPA-600/4-84-076. December.

EPA. 1988. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air.* Method TO-14. Atmospheric Research and Exposure Assessment Laboratory. Research Triangle Park, North Carolina. EPA-600/4-89/017. June.

EPA. 1990. "General Precautions in the Use of Canister Sampling for Measuring VOCs in Ambient Air." Office of Solid Waste and Emergency Response. Bulletin Board.

1.5 REQUIREMENTS AND RESOURCES

When using the Tedlar® bag collection method, the following items are needed:

- A sampling port and attached sampling line, ready for sampling
- A pump (SKC universal flow pump or equivalent), capable of pumping at least 3 liters per minute to allow purging of the sample point prior to collection of soil gas samples
- Sampling lines (dedicated, 0.375-inch outer diameter Tygon® tubing) to connect all field equipment
- "Y"-branched plastic (Teflon®-lined if available) sampling hose for duplicate collection
- 500-cubic-centimeter (cm^3) Tedlar® bags, with metal fittings
- Vacuum chamber

When using glass sampling bulbs to collect soil gas, the following items are needed:

- A supply of clean 250- or 500-milliliter (mL) glass gas sampling bulbs with stopcock valves
- Tygon® tubing or equivalent of appropriate size to connect the sampling bulb to the sample port and vacuum system
- A vacuum pump to purge the sampling system and to allow for sample collection. A vacuum/volume system capable of measuring purge volumes is desirable.
- A sampling system with an inline pressure gauge
- A source of heated air to purge and decontaminate the reusable glass sampling bulbs prior to initial use and between each subsequent use. This may consist of a simple hand-held hair drier.

When using steel canisters to collect soil gas, the following items are needed:

- A supply of clean, evacuated stainless-steel canisters (SUMMA® canisters) with a pressure gauge to verify internal pressure
- A vacuum pump (SKC universal flow pump or equivalent) to allow purging of the sample point prior to collection of soil gas samples
- Tygon® tubing or equivalent of appropriate size for connecting the sampling port to pump (during gas point purging) and the sampling port to stainless steel canister (during sample collection)
- Y-branched tubing (plastic, Teflon®-lined if available) for duplicate collection

2.0 PROCEDURES

This section describes selection of soil gas sampling locations and general preparation of the sampling system to be used. This section also provides detailed procedures for collecting samples using Tedlar® bags, glass bulbs, and stainless-steel canisters. Finally, this section discusses additional considerations that affect soil gas sampling (including duplicate and equipment blank sample collection, decontamination, and sample transfer) and summarizes the advantages and disadvantages of each sampling method.

2.1 SAMPLING LOCATION SELECTION

Sampling locations should be selected and prepared for sampling as described in a project-specific field sampling plan (FSP). Soil gas samples may be collected from depths as shallow as 3 feet or as great as 50 feet, depending on the objectives of the project, the site soil conditions, and the specific equipment used to penetrate to depth.

2.2 SAMPLING SYSTEM PREPARATION

Typical sample probe assemblies may consist of three types: (1) a hand-driven soil gas probe 4 feet in length, (2) a drill rig-driven soil gas probe 2 feet in length, and (3) a hydraulic-driven soil gas probe 3 feet in length. The probes may be assembled in series to reach the desired sampling depth. The probes will be driven to or emplaced at the desired sample collection depth, and then fitted with the Tygon® sampling line.

Once fitted with the sampling line, the ambient air within the sampling system is purged. Usually, three system volumes are purged prior to sample collection. If the sampling system purge volume cannot be measured, then a standard purge time of 3 to 5 minutes should be used.

After the system is purged of ambient air but before the pump is turned off, about 2 inches of the sampling line closest to the entrance port of the pump should be folded over itself and the tubing should be clamped to keep ambient air from reentering the system. This is not necessary when sampling with glass bulbs because the bulbs are already connected to the sampling line. After the system is purged and sealed to ambient air, the pump should be turned off. Sample collection can now proceed using a Tedlar® bag, a glass bulb, or a stainless-steel canister.

2.3 SAMPLE COLLECTION USING TEDLAR® BAGS

Soil gas can be collected for chemical analysis in a 500-cm^3 Tedlar® gas sampling bag. This can be accomplished by using an SKC pump to induce a vacuum on the exterior of the bag. This will cause the Tedlar® bag to be inflated with soil gas. The following procedure should be used:

1. Connect the free end of the Tygon® tubing (previously inserted through the top of the vacuum chamber) to the Tedlar® gas sampling bag. Open the valve on the gas sampling bag and place the tubing into the body of the vacuum chamber.

2. Place the top on the vacuum chamber.

3. Connect the free end of the evacuation tube to the SKC pump.

4. Turn on the pump. This should create a vacuum in the chamber, and the Tedlar® bag should fill at a rate of approximately 2 liters per minute. The rate at which the Tedlar® gas sampling bag fills will depend on the porosity and permeability of the soil.

5. The minimum amount of soil gas needed for analysis is approximately 0.25 liter.

6. If less than 0.25 liter is collected after 4 minutes of sampling, raise the soil gas probe 0.5 foot (if possible). Continue to evacuate the vacuum chamber for another minute. If the minimum required soil gas is not collected, repeat the procedure again. If the minimum required volume of soil gas is still not collected, abandon the collection process. All steps conducted are to be accurately recorded in the field logbook.

7. Remove the top of the vacuum chamber after the soil gas sample is collected in the Tedlar® bag.

8. Close the valve on the Tedlar® gas sampling bag, clamp the Tygon® tubing, and remove the Tedlar® gas sampling bag.

9. Turn off the pump.

10. Label the Tedlar® bag and its corresponding field datasheet (see Attachment A) with the sample number. An alternative documentation procedure is to enter the requisite information in the field logbook. Fill out the rest of the field datasheet.

2.4 SAMPLE COLLECTION USING GLASS BULBS

Soil gas also can be collected for chemical analysis in a glass bulb. When this sampling method is used, the glass bulb must be connected to the sampling system and purged of ambient air along with the sampling line before the sample is collected. The system is purged and the sample is collected using the following procedure:

1. Connect one end of the glass bulb to the sample line and the other end of the glass bulb to the vacuum pump using Tygon® tubing, and then open both stopcocks on the bulb.

2. Turn on the vacuum pump and purge the sampling system as discussed in Section 2.2.

3. Turn off the vacuum pump.

4. Observe the inline pressure gauge to determine when the vacuum in the bulb has been filled with soil gas. This may require several minutes, particularly in soils with low porosity and permeability. If the vacuum in the bulb has not dropped after 4 minutes of sampling, raise the soil gas probe in 0.5-foot increments in an attempt to find a more permeable zone. If the soil gas probe is moved, guard against leakage of ambient air into the system and repurge if necessary.

5. Once the vacuum in the gas sampling bulb has been filled, close off the upstream stopcock on the bulb, then the downstream stopcock and disconnect the bulb from the sample line.

6. Label the glass bulb and its corresponding field datasheet (see Attachment A) with the sample number. An alternative documentation procedure is to enter the requisite information in the field logbook. Fill out the rest of the field datasheet.

2.5 SAMPLE COLLECTION USING STAINLESS-STEEL CANISTERS

Soil gas also can be collected for chemical analysis in a stainless-steel, evacuated canister. Often, these canisters are used to collect duplicate samples for off-site analysis from locations that are being sampled for field screening analysis using Tedlar® bags or glass bulbs.

When this method is used, the canister is connected directly to the purged Tygon® sampling tube. To prevent ambient air from entering the canister during sample collection, all connections must be airtight. To collect soil gas samples using this method, the following procedure is used:

1. Measure the canister pressure reading, ambient air temperature, and ambient air pressure, and record the readings in the field logbook before sample collection.

2. Open the canister pressure valve, which will allow the evacuated stainless-steel canister to draw in soil gas until the canister reaches ambient pressure. When the sampling valve on the canister shows that ambient pressure has been reached, close the sampling valve and remove the canister from the sampling line.

3. Measure and record the post-sampling pressure reading on the canister pressure valve.

4. Label the canister and its corresponding field datasheet (see Attachment A) with the sample number. An alternative documentation procedure is to enter the requisite information in the field logbook. Fill out the rest of the field datasheet.

2.6 DUPLICATE AND EQUIPMENT BLANK COLLECTION

Duplicate soil gas samples will be collected at each site as required in the project-specific FSP. Generally, one duplicate sample will be collected for every ten samples collected. Each duplicate is collected in conjunction with a corresponding environmental sample.

To collect duplicate samples, a Y-branched sampling hose will be connected to the vacuum chamber or pump. Two Tedlar® bags, glass bulbs, or stainless-steel canisters will be attached, one to each end of the Y-branched hose. Sample collection will proceed as described above. After collection, one sample will be labeled as the environmental sample and one as the duplicate.

Equipment blanks also will be collected at each site as required in the project-specific FSP. Generally, one blank will be collected for every ten samples collected. Blanks will be collected by running ambient air through the sampling system immediately after it has been decontaminated, and by collecting the ambient air in a Tedlar® bag, glass bulb, or stainless-steel canister using the same procedures used to collect environmental samples. Blank sample collection is conducted upwind of any observed interference, and the location of the sampling should be recorded in the field logbook. Equipment blanks are collected to ensure that field equipment decontamination procedures are adequate.

2.7 DECONTAMINATION

Sampling probes should be decontaminated before the first sample is collected and between sampling points. Probes that are grossly contaminated should be decontaminated using a high-pressure steam cleaner. Probes that are not grossly contaminated can be decontaminated by brushing off loose soil particles, then heating the probes until they are warm to the touch to drive off any volatile contaminants. Heating times of 7 to 10 minutes are generally sufficient for this purpose. This brushing and heating method greatly reduces the generation of decontamination fluids.

Glass sampling bulbs also must be decontaminated between each use. This may be accomplished by purging heated air through the bulbs using a hand-held hair drier and the vacuum pump. Highly contaminated bulbs may require decontamination using either a methanol or soapy water wash and a deionized water rinse.

If Y-branched tubing or any other sampling equipment is to be reused, it must also be decontaminated between sampling locations.

2.8 SAMPLE TRANSFER

After collection, each sample container will be transported to the designated laboratory for analysis. In many cases, samples will be analyzed on site in a mobile laboratory.

2.9 ADVANTAGES AND DISADVANTAGES OF EACH SAMPLING METHOD

Tedlar® bags are relatively inexpensive to use but can only be used once and then must be disposed of. If the soil formation being sampled has a low porosity and permeability, such as clay or silty clay, it may not be possible to fully inflate the Tedlar® bag with soil gas.

Glass bulbs are more expensive than Tedlar® bags but they can be reused indefinitely, as long as they are not broken. However, bulbs must be decontaminated between each use, and periodic equipment blanks must be analyzed to verify that the decontamination procedures used are effective.

Stainless-steel canisters are very expensive and, therefore, are not cost-effective when conducting on-site analysis. The advantage of this type of sampler is that confirmation samples may be collected and shipped off-site for analysis with excellent assurance of sample integrity.

3.0 PRECAUTIONS

Both Tedlar® bags and glass bulbs are transparent to light, and many volatile compounds are subject to degradation in sunlight. As a result, samples should be stored in a dark place, such as a cooler, and analyzed as quickly as possible. In general, samples collected in Tedlar® bags or glass bulbs should be analyzed within 24 hours after collection, at a maximum. This will ensure sample integrity and minimize contaminant loss by degradation processes or absorption onto surfaces.

The concentration of volatile organic contaminants in the vapor phase in soil gas is a function of many complex and dynamic variables. Soil gas results do not usually show a direct correlation to groundwater contamination. However, soil gas may reflect to groundwater contaminant conditions and can be a useful tool for locating sources of volatile organic contamination in groundwater quickly and inexpensively.

While sampling, each sampling location should be screened with a flame ionization detector (FID) or photoionization detector (PID) following sample collection. The result of the FID or PID screening should be recorded on the sample container and field sheet so that the chemist analyzing the sample can determine whether sample dilutions or smaller sample volumes are required for analysis.

ATTACHMENT A

FIELD DATASHEET FOR SOIL GAS SAMPLING METHODS

FIELD DATASHEET FOR SOIL GAS SAMPLING METHODS

Date: ______________________________ Project/Site Name: _________________________________

Time: ______________________________ MWO No.: ____

Sample Container: ______ Tedlar® Bag: ______ Glass Bulb: _______ SUMMA® Canister: ________

Sampling Location and Depth: ____

Description of Location: ____

Sample Location Purged: Yes ______________ FID or PID (circle one) Reading: __________________

Sample Relinquished By: __________________________ Date/Time: ________________________

Sample Received By: ______________________________ Date/Time: ________________________

Attach field copy of sample label or write in sample number.

Notes:

SOP APPROVAL FORM

THE PRESIDIO TRUST

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

GENERAL EQUIPMENT DECONTAMINATION

SOP NO. 014

REVISION NO. 00

Last Reviewed: December 2000

Quality Assurance Approved

12 Jan 01

Date

1.0 BACKGROUND

All nondisposable field equipment must be decontaminated before and after each use at each sampling location to obtain representative samples and to reduce the possibility of cross-contamination.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for decontaminating equipment in the field.

1.2 SCOPE

This SOP applies to decontaminating general nondisposable field equipment. To prevent contamination of samples, all sampling equipment must be thoroughly cleaned prior to each use.

1.3 DEFINITIONS

Nonphosphate soap: Alconox® and Liquinox® are common laboratory grade products

1.4 REFERENCES

U.S. Environmental Protection Agency (EPA). 1992. "RCRA Groundwater Monitoring: Draft Technical Guidance." Office of Solid Waste and Emergency Response. Washington, DC. EPA/530-R-93-001. November.

EPA. 1994. "Sampling Equipment Decontamination." Environmental Response Team SOP No. 2006. Revision No. 0.0. August 11. (On-Line Address: http://www.ert.org/media_resrcs/media_resrcs.asp.)

1.5 REQUIREMENTS AND RESOURCES

The equipment required to conduct decontamination is as follows:

- Scrub brushes
- Large wash tubs or buckets
- Squirt bottles
- Nonphosphate soap
- Tap water

- Distilled water
- Plastic sheeting
- Aluminum foil
- Methanol or hexane
- Dilute (0.1 N) nitric acid
- Steam cleaner

2.0 PROCEDURES

The procedures below discuss decontamination of personal protective equipment (PPE), drilling and monitoring well installation equipment, borehole soil sampling equipment, water-level measurement equipment, and general sampling equipment.

2.1 PERSONAL PROTECTIVE EQUIPMENT DECONTAMINATION

Personnel working in the field are required to follow specific procedures for decontamination prior to leaving the work area so that contamination is not spread off-site or to clean areas. All used disposable protective clothing, such as Tyvek® coveralls, gloves, and booties, will be containerized for later disposal. Decontamination water will be containerized in 55-gallon drums.

Personnel decontamination procedures will be as follows:

1. Wash neoprene boots (or neoprene boots with disposable booties) with Liquinox or Alconox solution and rinse with clean water. Remove booties and retain boots for subsequent reuse.
2. Wash outer gloves in Liquinox® or Alconox® solution and rinse in clean water. Remove outer gloves and place into plastic bag for disposal.
3. Remove Tyvek® or coveralls. Containerize Tyvek® for disposal and place coveralls in plastic bag for reuse.
4. Remove air purifying respirator (APR), if used, and place the spent filters into a plastic bag for disposal. Filters should be changed daily or sooner depending on use and application. Place respirator into a separate plastic bag after cleaning and disinfecting.
5. Remove disposable gloves and place them in plastic bag for disposal.
6. Thoroughly wash hands and face in clean water and soap.

2.2 DRILLING AND MONITORING WELL INSTALLATION EQUIPMENT DECONTAMINATION

All drilling equipment should be decontaminated before drilling operations begin, between borings, and at completion of the project. The locations for decontamination activities will be designated by the Trust project manager.

Monitoring well casing, screens, and fittings are assumed to be delivered to the site in a clean condition. However, they should be steam cleaned on-site prior to placement downhole. The drilling subcontractor will typically furnish the steam cleaner and water.

After cleaning the drilling equipment, field personnel should place the drilling equipment, well casing and screens, and any other equipment that will go into the hole on clean polyethylene sheeting. The drilling auger, bits, drill pipe, temporary casing, surface casing, and other equipment should be decontaminated by the drilling subcontractor by hosing down with a steam cleaner until thoroughly clean. Drill bits and tools that still exhibit particles of soil after the first washing should be scrubbed with a wire brush and then rinsed again with a high-pressure steam rinse.

All wastewater from decontamination procedures should be containerized.

2.3 BOREHOLE SOIL SAMPLING EQUIPMENT DECONTAMINATION

The soil sampling equipment should be decontaminated after each sample as follows:

1. Prior to sampling, scrub the split-barrel sampler and sampling tools in a bucket, containing Liquinox® or Alconox® solution, using a stiff, long bristle brush.
2. Steam clean the sampling equipment over the rinsate tub and allow to air dry or rinse with deionized (distilled) water.
3. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.
4. Containerize all water and rinsate.
5. Decontaminate all pipe placed down the hole as described for drilling equipment.

2.4 WATER-LEVEL MEASUREMENT EQUIPMENT DECONTAMINATION

Field personnel should decontaminate the well sounder and interface probe before inserting and after removing them from each well. The following decontamination procedures should be used:

1. Wipe the sounding cable with a disposable soap-impregnated cloth or paper towel.
2. Rinse with deionized (distilled) organic-free water.

2.5 GENERAL SAMPLING EQUIPMENT DECONTAMINATION

All nondisposable sampling equipment should be decontaminated using the following procedures:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of protection as was used for sampling.
3. If a steam cleaner is not available, to decontaminate a piece of equipment, use an Alconox® wash; a tap water wash; a solvent (methanol or hexane) rinse, if applicable or dilute (0.1 N) nitric acid rinse, if applicable; a distilled water rinse; and air drying. Use a solvent (methanol or hexane) rinse for grossly contaminated equipment (for example, equipment that is not readily cleaned by the Alconox® wash). The dilute nitric acid rinse may be used if metals are the analyte of concern.
4. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.
5. Containerize all water and rinsate.

SOP APPROVAL FORM

THE PRESIDIO TRUST

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

PACKAGING AND SHIPPING SAMPLES

SOP NO. 015

REVISION NO. 00

Last Reviewed: December 2000

Quality Assurance Approved

12 JAN 01

Date

1.0 BACKGROUND

In any sampling program, the integrity of a sample must be ensured from its point of collection to its final disposition. Procedures for classifying, packaging, and shipping samples are described below. Steps in the procedures should be followed to ensure sample integrity and to protect the welfare of persons involved in shipping and receiving samples. When hazardous substances and dangerous goods are sent by common carrier, their packaging, labeling, and shipping are regulated by the U.S. Department of Transportation (DOT) Hazardous Materials Regulations (HMR) (*Code of Federal Regulations*, Title 49 [49 CFR] Parts 106 through 180) and the International Air Transportation Association (IATA) Dangerous Goods Regulations (DGR).

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for packaging and shipping samples. It has been prepared in accordance with the U.S. Environmental Protection Agency (EPA) "Sampler's Guide to the Contract Laboratory Program (CLP)," the DGR, and the HMR. Sample packaging and shipping procedures described in this SOP should be followed for all sample packaging and shipping. Deviations from the procedures in this SOP must be documented in a field logbook. This SOP assumes that samples are already collected in the appropriate sample jars and that the sample jars are labeled and tagged appropriately.

1.2 SCOPE

This SOP applies to sample classification, packaging, and shipping.

1.3 DEFINITIONS

Chain of Custody: Document indicating custody of the samples at all times between sampling and analysis.

Custody Seal: A custody seal is a tape-like seal. Placement of the custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been packaged for shipping.

Dangerous Goods: Dangerous goods are articles or substances that can pose a significant risk to health, safety, or property when transported by air; they are classified as defined in Section 3 of the DGR (IATA 1999).

Environmental Samples: Environmental samples include drinking water, groundwater and surface water, soil, sediment, treated municipal and industrial wastewater effluent, and biological specimens. Environmental samples typically contain low concentrations of contaminants and when handled require only limited precautionary procedures.

Hazardous Materials Regulations: The HMRs are DOT regulations for the shipment of hazardous materials by air, water, and land; they are located in 49 CFR 106 through 180.

Hazardous Samples: Hazardous samples include dangerous goods and hazardous substances. Hazardous samples shipped by air should be packaged and labeled in accordance with procedures specified by the DGR; ground shipments should be packaged and labeled in accordance with the HMR.

Hazardous Substance: A hazardous substance is any material, including its mixtures and solutions, that is listed in Appendix A of 49 CFR 172.101 and its quantity, in one package, equals or exceeds the reportable quantity (RQ) listed in the appendix.

IATA Dangerous Goods Regulations: The DGRs are regulations that govern the international transport of dangerous goods by air. The DGRs are based on the International Civil Aviation Organization (ICAO) Technical Instructions. The DGR contain all of the requirements of the ICAO Technical Instructions and are more restrictive in some instances.

Nonhazardous Samples: Nonhazardous samples are those samples that do not meet the definition of a hazardous sample and **do not** need to be packaged and shipped in accordance with the DGR or HMR.

Overpack: An enclosure used by a single shipper to contain one or more packages and to form one handling unit (IATA 1999). For example, a cardboard box may be used to contain three fiberboard boxes to make handling easier and to save on shipping costs.

1.4 REFERENCES

U.S. Department of Transportation, Transport Canada, and the Secretariat of Communications and Transportation of Mexico (DOT and others). 1996. *1996 North American Emergency Response Guidebook.*

International Air Transport Association (IATA). 1997. *Guidelines for Instructors of Dangerous Courses.*

IATA. 1999. *Dangerous Goods Regulations.* 40th Edition.

U.S. Environmental Protection Agency. 1994. "Sampler's Guide to the Contract Laboratory Program." Office of Solid Waste and Emergency Response. Washington, DC. EPA/540/R-96/032. On-Line Address: http://www.epa.gov/oerrpage/superfund/programs/clp/guidance.htm - sample

1.5 REQUIREMENTS AND RESOURCES

The procedures for packaging and shipping **nonhazardous** samples require the following:

- Coolers
- Ice
- Vermiculite, bubble wrap, or similar cushioning material
- Chain-of-custody forms and seals
- Airbills
- Resealable plastic bags for sample jars and ice
- Tape (strapping and clear)

The procedures for packaging and shipping **hazardous** samples require the following:

- Ice
- Vermiculite or other noncombustible, absorbent packing material
- Chain-of-custody forms and seals
- Appropriate dangerous goods airbills and emergency response information to attach to the airbill
- Resealable plastic bags for sample jars and ice

- Tape (strapping and clear)

- Appropriate shipping containers, as specified in the DGR

- Labels that apply to the shipment such as hazard labels, address labels, "Cargo Aircraft Only" labels, and package orientation labels (up arrows)

2.0 PROCEDURES

The following procedures apply to packing and shipping nonhazardous and hazardous samples.

2.1 SAMPLE CLASSIFICATION

Prior to sample shipment by air courier, it must be determined whether the sample is subject to the DGR. Samples subject to these regulations shall be referred to as hazardous samples. Any airline belonging to IATA must follow the DGR. As a result, these air carriers **may not** accept a shipment that is packaged and labeled in accordance with the HMR (although in most cases, the packaging and labeling would be the same for either set of regulations). The HMR states that a hazardous material may be transported by aircraft in accordance with the ICAO Technical Instruction (49 CFR 171.11) upon which the DGR is based. Therefore, the use of the DGR for samples to be shipped by air complies with the HMR, but not vice versa.

Most environmental samples are not hazardous samples and do not need to be packaged in accordance with any regulations. Hazardous samples are those samples that can be classified as specified in Section 3 of the DGR, can be found in the List of Dangerous Goods in the DGR in bold type, are considered a hazardous substance (see definition), or are mentioned in "Section 2 - Limitations" of the DGR for countries of transport or airlines (such as FedEx). The hazard classifications specified in the DGR (and the HMR) are as follows:

Class 1 – Explosives

Division 1.1 – Articles and substances having a mass explosion hazard
Division 1.2 – Articles and substances having a projection hazard but not a mass explosion hazard
Division 1.3 – Articles and substances having a fire hazard, a minor blast hazard, and/or a minor projection hazard but not a mass explosion hazard
Division 1.4 – Articles and substances presenting no significant hazard
Division 1.5 – Very sensitive substances mass explosion hazard

Division 1.6 – Extremely insensitive articles, which do not have a mass explosion hazard

Class 2 – Gases

Division 2.1 – Flammable gas
Division 2.2 – Nonflammable, nontoxic gas
Division 2.3 – Toxic gas

Class 3 – Flammable Liquids

Class 4 – Flammable Solids; Substances Liable to Spontaneous Combustion; Substances, when in Contact with Water, Emit Flammable Gases

Division 4.1 – Flammable solids
Division 4.2 – Substances liable to spontaneous combustion
Division 4.3 – Substances, when in contact with water, emit flammable gases

Class 5 – Oxidizing Substances and Organic Peroxide

Division 5.1 – Oxidizers
Division 5.2 – Organic peroxides

Class 6 – Toxic and Infectious Substances

Division 6.1 – Toxic substances
Division 6.2 – Infectious substances

Class 7 – Radioactive Material

Class 8 – Corrosives

Class 9 – Miscellaneous Dangerous Goods

The criteria for each of the first eight classes are very specific and are outlined in Section 3 of the DGR and 49 CFR 173 of the HMR. Some classes and divisions are further divided into packing groups based on their level of danger. Packing group I indicates a great danger, packing group II indicates a medium danger, and packing group III indicates a minor danger. Class 2, gases, includes any compressed gas being shipped and any noncompressed gas that is either flammable or toxic. A compressed gas is defined as having a pressure over 40 pounds per square inch (psi) absolute (25 psi gauge). Most air samples and empty cylinders that did not contain a flammable or toxic gas are exempt from the regulations. An empty hydrogen cylinder, as in a flame ionization detector (FID), is considered a dangerous good unless it is properly purged with nitrogen in accordance with the HMR. A landfill gas sample is usually considered a

flammable gas because it may contain a high percentage of methane. Class 3, flammable liquids, are based on the boiling point and flash point of a substance. Most class 3 samples include solvents, oil, gas, or paint-related material collected from drums, tanks, or pits. Division 6.1, toxic substances, is based on oral toxicity (LD_{50} [lethal dose that kills 50 percent of the test animals]), dermal toxicity (LD_{50} values), and inhalation toxicity (LC_{50} [lethal concentration that kills 50 percent of the test animals] values). Division 6.1 substances include pesticides and cyanide. Class 7, radioactive material, is defined as any article or substance with a specific activity greater than 70 kiloBecquerels (kBq/kg) (0.002 [microCuries per gram [μCi/g]). If the specific activity exceeds this level, the sample should be shipped in accordance with Section 10 of the DGR. Class 8, corrosives, is based on the rate at which a substance destroys skin tissue or corrodes steel; they are not based on pH. Class 8 materials include the concentrated acids used to preserve water samples. Preserved water samples are not considered class 8 substances and should be packaged as nonhazardous samples. Class 9, miscellaneous dangerous goods, is substances that present a danger, but are not covered by any other hazard class. Examples of class 9 substances include asbestos, polychlorinated biphenyls (PCB), and dry ice.

Unlike the DGR, the HMR includes combustible liquids in hazard class 3. The definition of a combustible liquid is specified in 49 CFR 173.120 of the HMR. The HMR has an additional class, ORM-D, which is not specified in the DGR. "ORM-D material" refers to a material such as a consumer commodity, which although otherwise subject to the HMR, presents a limited hazard during transport due to its form, quantity, and packaging. It must be a material for which exceptions are provided in the table of 49 CFR 172.101. The DGR lists consumer commodities as a class 9 material.

In most instances, the hazard of a material sampled is unknown because no laboratory testing has been conducted. A determination as to the suspected hazard of the sample must be made using knowledge of the site, field observations, field tests, and other available information.

According to 40 CFR 261.4(d) and (e), samples transported to a laboratory for testing or treatability studies, including samples of hazardous wastes, are **not** hazardous wastes. Air carriers will not accept a shipment of hazardous waste.

2.2 PACKAGING NONHAZARDOUS SAMPLES

Nonhazardous samples, after being appropriately containerized, labeled, and tagged, should be packaged in the following manner.

1. Place the sample in a resealable plastic bag.

2. Place the bagged sample in a cooler and pack it to prevent breakage.

3. Prevent breakage of bottles during shipment by either wrapping the sample container in bubble wrap, or lining the cooler with a noncombustible material such as vermiculite. Vermiculite is especially recommended because it will absorb any free liquids inside the cooler. It is recommended that the cooler be lined with a large plastic garbage bag before samples, ice, and absorbent packing material are placed in the cooler.

4. Add a sufficient quantity of ice to the cooler to cool samples to 4 °C. Ice should be double bagged in resealable plastic bags to prevent the melted ice from leaking out. As an option, a temperature blank (a sample bottle filled with distilled water) can be included with the cooler.

5. Seal the completed chain-of-custody forms in a plastic bag and tape the plastic bag to the inside of the cooler lid.

6. Tape any instructions for returning the cooler to the inside of the lid.

7. Close the lid of the cooler and tape it shut by wrapping strapping tape around both ends and hinges of the cooler at least once. Tape shut any drain plugs on the cooler.

8. Place two signed custody seals on the cooler, ensuring that each one covers the cooler lid and side of the cooler. Place clear plastic tape over the custody seals.

9. Place address labels on the outside of the cooler, if samples are to be shipped by a commercial carrier.

2.2 PACKAGING HAZARDOUS SAMPLES

Packaging of hazardous samples should only be performed by individuals with DOT shipping training. The procedures for packaging hazardous samples are summarized below. Note that according to the DGR, all spellings must be exactly as they appear in the List of Dangerous Goods, and only approved abbreviations are acceptable. The corresponding HMR regulations are provided in parentheses following any DGR references. The HMR must be followed only if shipping hazardous samples by ground transport.

1. Determine the proper shipping name for the material to be shipped. All proper shipping names are listed in column B of the List of Dangerous Goods table in Section 4 of the DGR (or column 2 of the Hazardous Materials Table in 49 CFR 172.101). In most instances, a generic name based on the hazard class of the material is appropriate. For example, a sample of an oily liquid collected from a drum with a high photoionization detector (PID) reading should be packaged as a flammable liquid. The proper shipping name chosen for this sample would be "flammable liquid, n.o.s." The abbreviation "n.o.s." stands for "not otherwise specified" and is used for generic shipping names. Typically, a specific name, such as acetone, should be inserted in parentheses after most n.o.s. descriptions. However, a technical name is not required when shipping a sample for testing purposes and the components are not known. If shipping a hazardous substance (see definition), then the letters "RQ" must appear in front of the proper shipping name.

2. Determine the United Nations (UN) identification number, class or division, subsidiary risk if any, required hazard labels, packing group, and either passenger aircraft or cargo aircraft packing instructions based on the quantity of material being shipped in one package. This information is provided in the List of Dangerous Goods (or Hazardous Materials Table in 49 CFR 172.101) under the appropriate proper shipping name. A "Y" in front of a packing instruction indicates a limited quantity packing instruction. If shipping dry ice or a limited quantity of a material, then UN specification shipping containers do not need to be used.

3. Determine the proper packaging required for shipping the samples. Except for limited quantity shipments and dry ice, these UN specification packages have been tested to meet the packing group of the material being shipped. Specific testing requirements of the packages are listed in Section 6 of the DGR (or 49 CFR 178 of the HMR). All UN packages are stamped with the appropriate UN specification marking. Prior planning is required to have the appropriate packages on hand during a sampling event where hazardous samples are anticipated. Most samples can be shipped in either a 4G fiberboard box, a 1A2 steel drum, or a 1H2 plastic drum. Drums can be purchased in 5- and 20-gallon sizes and are ideal for shipping multiple hazardous samples. When FedEx is used to ship samples containing PCBs, the samples must be shipped in an inner metal packaging (paint can) inside a 1A2 outer steel drum. This method of packaging PCB samples is in accordance with FedEx variation FX-06, listed in Section 2 of the DGR.

4. Place each sample jar in a separate resealable plastic bag. Some UN specification packages contain the sample jar and plastic bag to be used when shipping the sample.

5. Place each sealed bag inside the approved UN specification container (or other appropriate container if a limited quantity or dry ice) and pack with enough noncombustible, absorbent, cushioning material (such as vermiculite) to prevent breakage and to absorp liquid.

6. Place chain-of-custody forms in a resealable plastic bag and either attach it to the inside lid of the container or place it on top inside the container. Place instructions for returning the container to the shipper on the inside lid of the container as appropriate. Close and seal the shipping container in the manner appropriate for the type of container being used.

7. Label and mark each package appropriately. All irrelevant markings and labels need to be removed or obliterated. All outer packaging must be marked with proper shipping name, UN identification number, and name and address of the shipper and the recipient. For carbon dioxide, solid (dry ice), the net weight of the dry ice within the package needs to be marked on the outer package. For limited quantity shipments, the words "limited quantity" or "LTD. QTY." must be marked on the outer package. Affix the appropriate hazard label to the outer package. If the material being shipped contains a subsidiary hazard, then a subsidiary hazard label must also be affixed to the outer package. The subsidiary hazard label is identical to the primary hazard label except that the class or division number is not present. It is acceptable to obliterate the class or division marking on a primary hazard label and use it as the subsidiary hazard label. If using cargo aircraft only packing instructions, then the "Cargo Aircraft Only" label must be used. Package orientation labels (up arrows) must be placed on opposite sides of the outer package. Figure 1 depicts a properly marked and labeled package.

8. If using an overpack (see definition), mark and label the overpack and each outer packaging within the overpack as described in step 7. In addition, the statement "INNER PACKAGES COMPLY WITH PRESCRIBED SPECIFICATIONS" must be marked on the overpack.

9. Attach custody seals, and fill out the appropriate shipping papers as described in Section 2.4.

2.4 SHIPPING PAPERS FOR HAZARDOUS SAMPLES

A "Shippers Declaration for Dangerous Goods" and "Air Waybill" must be completed for each shipment of hazardous samples. Air carriers generally supply a their own Dangerous Goods Airbill to their customers; the airbill typically combines both the declaration and the waybill. An example of a completed Dangerous Goods Airbill is depicted in Figure 2. A shipper's declaration must contain the following:

- Name and address of shipper and recipient
- Air waybill number (not applicable to the HMR)
- Page ___ of ___
- Deletion of either "Passenger and Cargo Aircraft" or "Cargo Aircraft Only," whichever does not apply
- Airport or city of departure
- Airport or city of destination
- Deletion of either "Non-Radioactive" or "Radioactive," which ever does not apply

- The nature and quantity of dangerous goods. This includes the following information in the following order (obtained from the List of Dangerous Goods in the DGR): proper shipping name, class or division number, UN identification number, packing group number, subsidiary risk, quantity in liters or kilograms (kg), type of packaging used, packing instructions, authorizations, and additional handling information. Authorizations include the words "limited quantity" or "LTD. QTY." if shipping a limited quantity, any special provision numbers listed in the List of Dangerous Goods in the DGR, and the variation "USG-14" when a technical name is required after the proper shipping name but not entered because it is unknown.

- Signature for the certification statement

- Name and title of signatory

- Place and date of signing certification

- A 24-hour emergency response telephone number for use in the event of an incident involving the dangerous good

- Emergency response information attached to the shipper's declaration. This information can be in the form of a material safety data sheet or the applicable North American Emergency Response Guidebook (NAERG; DOT 1996) pages. Figure 3 depicts the appropriate NAERG emergency response information for "Flammable liquids, n.o.s." as an example.

Note that dry ice does not require an attached shipper's declaration. However, the air waybill must include the following on it: "Dry ice, 9, UN1845, ____ x ____ kg." The blanks must include the number of packages and the quantity in kg in each package. If using FedEx to ship dry ice, the air waybill includes a box specifically for dry ice. Simply check the appropriate box and enter in the number of packages and quantity in each package.

The HMR requirements for shipping papers are located in 49 CFR 172 Subpart C.

3.0 POTENTIAL PROBLEMS

The following potential problems may occur during sample shipment:

- Leaking package. If a package leaks, the carrier may open the package, return the package, and if a dangerous good, inform the Federal Aviation Administration (FAA), which can result in fines.

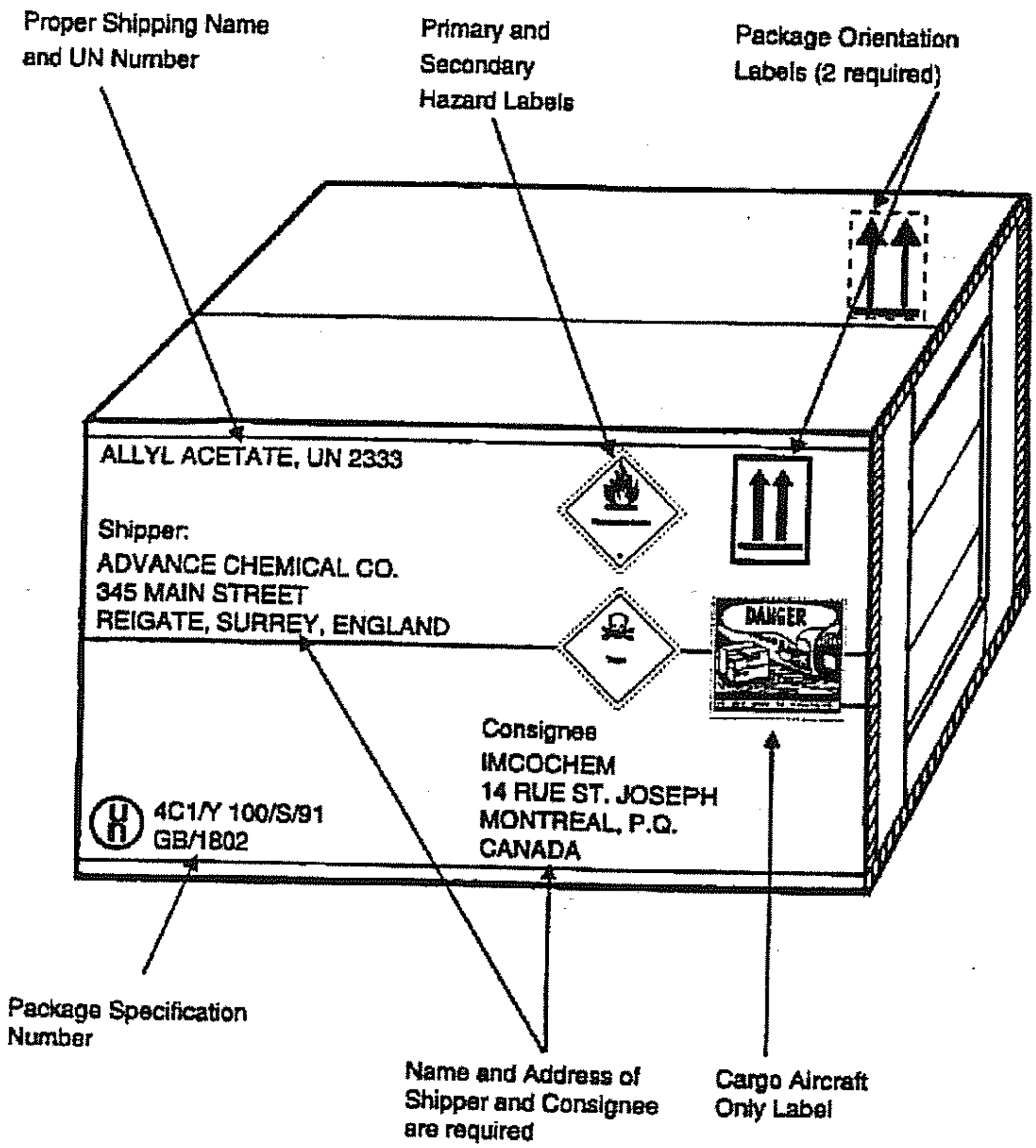
- Improper labeling and marking of package. If mistakes are made in labeling and marking the package, the carrier will most likely notice the mistakes and return the package to the shipper, thus delaying sample shipment.

- Improper, misspelled, or missing information on the shipper's declaration. The carrier will most likely notice this as well and return the package to the shipper.

Contact the air carrier with questions about dangerous goods shipments and ask for a dangerous goods expert.

FIGURE 1

EXAMPLE OF A CORRECTLY MARKED AND LABELED DANGEROUS GOODS PACKAGE



Source: International Air Transport Association (IATA). 1997.

FIGURE 2

EXAMPLE OF A DANGEROUS GOODS AIRBILL

FedEx Dangerous Goods Airbill — Senders Copy

The World On Time.

1 From
Date: FILL IN
Sender's FedEx Account Number: 1788-8C14-4
Sender's Name: FILL IN
Phone: (312) 856 8700
Company: TETRA TECH EM INC
Address: 200 E RANDOLPH ST STE 4700
City: CHICAGO State: IL ZIP: 60601

2 Your Internal Billing Reference: FILL IN

3 To
Recipient's Name / Company / Address / City / State / ZIP: FILL IN

Questions? Call 1-800-Go-FedEx

5 Packaging
☒ Other Packaging

6 Special Handling
☒ Dangerous Goods as per attached Shipper's Declaration

7 Payment
☒ Sender ☐ Recipient ☐ Third Party ☐ Credit Card ☐ Cash/Check

4a Express Package Service
☒ FedEx Priority Overnight ☐ FedEx Standard Overnight ☐ FedEx 2Day ☐ FedEx Express Saver

4b Express Freight Service
☐ FedEx 1Day Freight ☐ FedEx 2Day Freight ☐ FedEx 3Day Freight

Signature Release Unavailable

374

FedEx Tracking Number: 813350883058 Form I.D. No. 0204

Page 1 of 1 Pages

Two completed and signed copies of this Declaration must be handed to the operator.

WARNING
Failure to comply in all respects with the applicable Dangerous Goods Regulations may be in breach of the applicable law, subject to legal penalties. This Declaration must not, in any circumstances, be completed and/or signed by a consolidator, a forwarder or an IATA cargo agent.

TRANSPORT DETAILS
This shipment is within the limitations prescribed for: PASSENGER AND CARGO AIRCRAFT / ~~CARGO AIRCRAFT ONLY~~
Airport of Departure: Chicago
Airport of Destination: "City sending sample to"

Shipment type: NON-RADIOACTIVE ~~RADIOACTIVE~~

NATURE AND QUANTITY OF DANGEROUS GOODS

Proper Shipping Name	Class or Division	UN or ID No.	Packing Group	Subsidiary Risk	Quantity and Type of Packaging	Packing Inst.	Authorization
Flammable liquid, n.o.s.	3	UN 1993	III	—	4 glass jars in a 1A2 steel drum Net Quantity = 4 L	309	A3 USG-14

Additional Handling Information: NAERG # 128 Attached.

Prepared for AIR TRANSPORT according to: (Customer MUST check one) ☐ 49 CFR ☒ ICAO/IATA

I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name and are classified, packaged, marked, and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

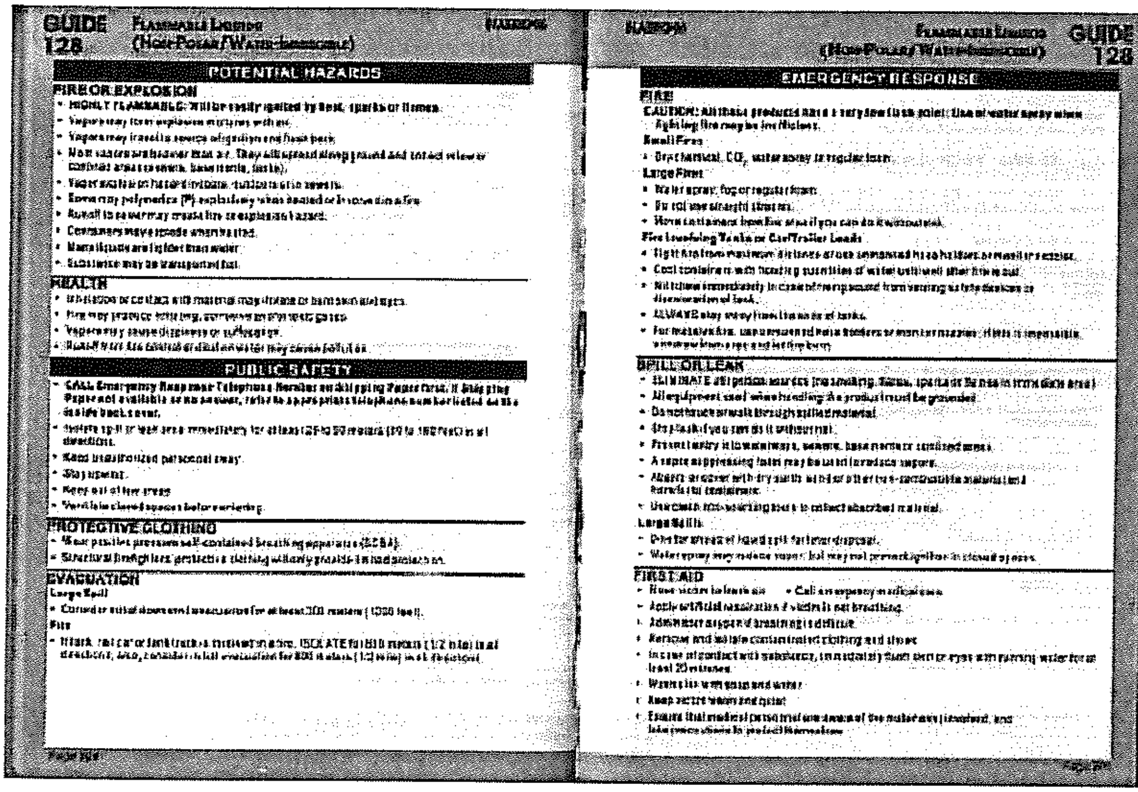
Name/Title of Signatory: Me, Environmental Scientist
Place and Date: 200 E Randolph, Chicago, IL xx/xx/xx
Signature: Me

Emergency Telephone Number: FILL IN

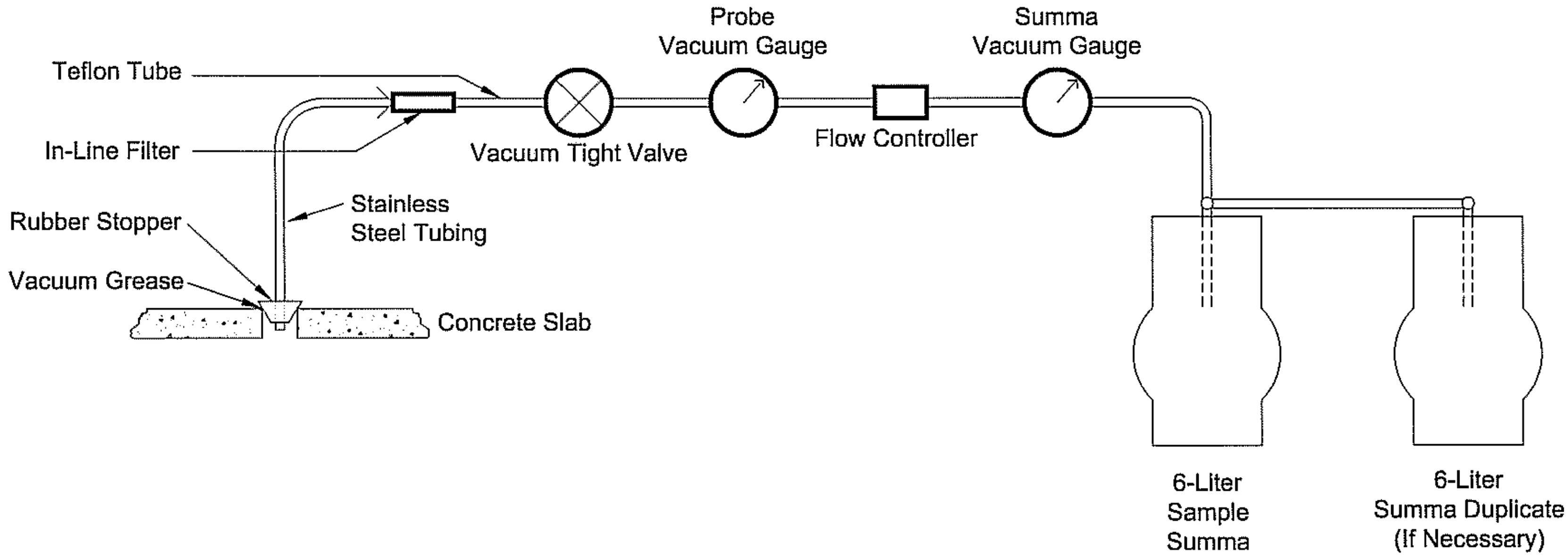
IF ACCEPTABLE FOR PASSENGER AIRCRAFT, THIS SHIPMENT CONTAINS RADIOACTIVE MATERIAL INTENDED FOR USE IN, OR INCIDENT TO, RESEARCH, MEDICAL DIAGNOSIS, OR TREATMENT.

FIGURE 3

NAERG EMERGECY RESPONSE INFORMATION FOR FLAMMABLE LIQUIDS, N.O.S.



Source: DOT and others. 1996.



Erler & Kalinowski, Inc.

Sub-Slab Soil Vapor Sampling Configuration

THE PRESIDIO TRUST

Presidio Trust
San Francisco, CA
October 2005
EKI A000003.08

Figure A-1